Using GIS to Create Childhood Lead Poisoning Guidelines in Florida

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Abstract

Over 900,000 children in the United States have blood lead levels high enough to cause health problems that range from learning disabilities to permanent neurological damage. The Florida Department of Health, Bureau of Environmental Epidemiology, was awarded a grant from the US Centers for Disease Control and Prevention (CDC) to conduct childhood lead poisoning surveillance in Florida. The CDC identified older housing stock as the most significant avenue for lead exposure in young children. In 1997, the CDC published screening guidelines that suggested universal screening for all children living in census block groups where 27% or more of the housing was built before 1950. However, dangerous amounts of lead were present in paint until the mid-1970s. Using a geographic information system (GIS), the Bureau of Environmental Epidemiology is developing statewide screening guidelines that are more appropriate to the unique demographics of Florida than the CDC guidelines. With ArcView software, many different variations of the CDC guidelines were examined quickly and easily. The Bureau assigned latitude and longitude coordinates to a table of 1993–1997 lead poisoning cases, then performed a tabular join to link the census housing data to the geographic block group data. ArcView was then used to isolate the housing age by block group in multiple combinations until the best fit with the case addresses was determined. This procedure enables county health departments to use targeted blood lead screening, thus maximizing the number of at-risk children being tested while consuming fewer resources than they would using universal screening.

Keywords: lead, poisoning, housing, block group, screening

Introduction

The United States Centers for Disease Control and Prevention (CDC) has estimated that 900,000 children less than six years of age have blood lead levels higher than 10 micrograms per deciliter. This seemingly low level of lead exposure has been scientifically documented to cause developmental abnormalities such as lower intelligence and reduced stature (1,2). Higher levels of blood lead can cause nervous system dysfunction, reduced blood oxygen capacity, kidney failure, and death.

Contrary to popular belief, lead poisoning is not limited to children of the poor or of minority members. Lead can afflict children regardless of their socioeconomic status and has been used so extensively by industrial society that it is virtually impossible not to consume it. This statement has been proven by the comparative measurement of

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lead in the bones of pre-Columbian New World dwellers to the bones of modern people. The bone lead levels of modern humans are on average 100 to 1,000 times higher than those of pre-Columbian humans (3). While these elevated bone lead levels are generally not high enough to be termed "lead poisoning" under current federal guidelines, the mere presence of lead at comparatively high concentrations in modern humans suggests the inevitability of lead ingestion and hints at the universal problem of lead poisoning.

For several reasons, children are more easily lead-poisoned than adults. First of all, "if the same concentration of lead is present in substances consumed, such as air, food, or water, children ingest or inhale a greater quantity relative to body weight than do adults" (4). This is because children have higher rates of respiration and metabolism than adults. Secondly, when children ingest lead, a greater quantity of that lead is retained in their bodies than in adults' bodies. For example, Ziegler et al. (5) discovered that infants between 14 days and two years old absorbed 42% of ingested lead and retained 32% of ingested lead. In contrast, adults are generally considered to absorb 5 to 10% of ingested lead (although nutritional factors play a significant role in absorption/retention) (4). The third reason for which children are more likely to be lead-poisoned in today's environment is that children, especially those between 0 and 72 months old, are more likely to engage in extensive hand-to-mouth activity. This means they are more likely to ingest lead-contaminated matter such as dust, soil, paint chips, or pottery. For children, the most significant of these sources is leaded paint in older housing. Lead was used extensively in residential paint until the federal government banned its use as an additive in 1978. However, thousands of children continue to be exposed to this deteriorating paint. The most effective methods of preventing childhood lead poisoning are to remove the lead paint from the child's environment or to protect the child from lead exposure. In practice, the elimination of childhood lead poisoning has been a painfully slow process because of a lack of public awareness and because of the sheer enormity of the problem.

The CDC has taken the lead in establishing policy directives to reduce the prevalence of childhood lead poisoning. Recognizing that state and local health agencies are better equipped to deal with the specific lead poisoning issues in their jurisdictions, the CDC has made extensive surveillance and prevention grant monies available to these government agencies. In Florida, the Department of Health, Bureau of Environmental Epidemiology, was awarded a statewide childhood lead poisoning surveillance grant in 1992. In that same year, childhood lead poisoning became a reportable disease in Florida, which means that state and private laboratories were required to report the results of all blood lead tests performed. The cases of childhood lead poisoning used in this study were drawn from the centralized database of the Florida Childhood Lead Poisoning Surveillance Program (CLPSP) for the years 1993 through 1997.

Most of the cases in the CLPSP database were tested by one of the 67 county health departments (CHDs) in Florida. There is a great deal of variability between the level of service provided by the different CHDs. Some counties (e.g., Pinellas, Duval) offer full-service health facilities, while others (e.g., Dade, Broward) have farmed their responsibilities out to private health agencies because of a lack of adequate budget to maintain proper health care services of their own. In the counties that do offer health care programs, most of the children enrolled are Medicaid recipients. Thus, most of the children tested for lead poisoning by the CHDs are Medicaid recipients. When these children are

tested, their blood is sent to the state laboratory in Jacksonville. The state laboratory is then required to send the results to the statewide surveillance database in Tallahassee.

In contrast, private physicians in the counties with little or no CHD services see a mixed bag of children on Medicaid and children with private insurance plans. Unfortunately, the majority of private physicians in Florida do not believe that childhood lead poisoning is a major health concern (6). Testing of blood lead levels by private physicians is sporadic at best, even for the children they see who are on Medicaid. This is significant because Medicaid requires and pays for childhood blood lead screening for all one- and two-year-olds. However, no government agency is enforcing the mandatory blood lead testing required for children on Medicaid.

For children in cost-conscious HMOs, the prospects of a blood test are even less promising. For example, one of the Florida Department of Health employees who administers the statewide lead poisoning database could not get her insurance to pay for a blood lead test for her children because her physician would not approve it. Like many other doctors, he did not believe the infants were in any danger, even though the employee lived in a house built before 1978.

In addition to sponsoring grants for childhood lead poisoning surveillance, the CDC has taken an active role in the delineation of lead poisoning hazards. In 1997, the CDC published a short document entitled *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials* (7). The purpose of this document was to reiterate the CDC's commitment to the surveillance and prevention of childhood lead poisoning. It recommended a basic targeted screening plan as an interim measure while local data were being reviewed. In other words, local health departments should make a concerted effort to test all children living in areas with greater than or equal to 27% pre-1950 housing (the national percentage). The areas that exceed this national percentage of pre-1950 housing are more likely to contain lead-poisoned children. However, the CDC admits that this definition of what areas to target may not be adequate for all jurisdictions, since a substantial threat remains in housing built between 1950 and 1978. This is precisely the case for the state of Florida, where the building boom did not occur until after World War II.

In comparison to the national situation, Florida's housing does not appear to be as hazardous to young children. Only 7.7% of Florida housing was built before 1950, a percentage that is 47th out of 50 states. However, this percentage represents 472,481 homes, which places Florida 19th out of 50 states in sheer numbers of pre-1950 houses. Furthermore, because the phase-out of leaded paint for residential uses was not complete until 1978, homes built between 1950 and approximately 1970 still represent a significant hazard to children. In Florida, the number of homes built between 1950 and 1970 is 1,708,205, or approximately 3½ times more than in all previous years combined.

Clearly, the CDC recommendation to screen all children living in areas with at least 27% pre-1950 housing may not be ideally suited to Florida, considering the large number of homes built between 1950 and 1970. In other words, using pre-1950 housing alone would not capture enough of the lead poisoning risk. The Bureau of Environmental Epidemiology has taken the initiative in analyzing state childhood lead poisoning data in conjunction with 1990 census data. The ultimate objective of this analysis is to publish a modified screening recommendation to aid in focused screening efforts.

Methods

In order to analyze the geography of childhood lead poisoning in Florida, the statewide database of children with elevated lead levels first had to be geocoded. This process used the residential address from each record in the CLPSP database to assign a latitude and longitude based on where the address fell on the specific street segment. This was possible because nearly every road in Florida has been entered into a geographic information system (GIS) database. This GIS stores the latitude and longitude of every road segment, as well as the address ranges (house numbers) found along it. In this manner, the cases were added to the Florida Department of Health's GIS in order to analyze the case locations at various geographic levels.

The county level was chosen as the most appropriate unit for GIS analysis. The analysis is still ongoing, and only preliminary results are available at this time. For the presentation at the 1998 GIS in Public Health conference, Pinellas County, Florida, was chosen to demonstrate the methodology of analyzing the spatial arrangement of childhood lead poisoning cases in relation to housing data from the 1990 census. Pinellas County is a metropolitan county containing the cities of St. Petersburg and Clearwater. It was one of the earliest counties in Florida to undergo a population explosion (mostly as a result of in-migration) after World War II. As a result, Pinellas County contains a significant number of older homes with deteriorating lead-based paint.

Three years ago, the Pinellas County Health Department (PCHD) was awarded an individual surveillance grant from the CDC. With this federal money, the PCHD administered surveys to determine what areas of the county present the greatest lead poisoning risk to children. Using this knowledge, the PCHD has been able to find more lead-poisoned children than many other counties in Florida. Furthermore, the cases of lead poisoning found by the PCHD are more representative of the overall population of children than are the findings of many counties in Florida. For these reasons, Pinellas County was chosen for the initial GIS analysis of lead poisoning cases in relation to older housing.

Data on the childhood lead poisoning cases for Pinellas County were overlaid on 1990 census block groups. Using GIS, different combinations of older housing could be isolated and then analyzed with the cases. First of all, the CDC recommendation of universal screening in block groups made up of at least 27% pre-1950 housing was tested to see what percentage of cases fall in this defined area. The answer was 65%. A modified standard of at least 58% pre-1970 housing was then used; 84% of the cases fell within this area, for an overall improvement of 19%. The use of this modified recommendation would increase the number of children with elevated lead levels discovered through universal screening in these areas. In the future, more elaborate GIS analyses will be performed using other census variables, such as percent single mothers, percent below poverty line, percent black, etc. This could serve to focus screening efforts to a more sophisticated level than ever before through the use of GIS to analyze childhood lead poisoning cases in relation to demographic data.

Conclusion

In conclusion, childhood lead poisoning remains a problem in the United States despite persistent efforts to reduce its prevalence. Leaded paint in older housing is the single

greatest exposure route for childhood lead poisoning. The CDC has recommended universal screening of children in areas where at least 27% of the housing was built before 1950. However, the CDC is aware of the fact that this recommendation is not ideally suited to all jurisdictions. The Florida Department of Health is using GIS to examine the geography of childhood lead poisoning cases extracted from the statewide CLPSP database. Early indications from the analysis of Pinellas County reveal that a modified CDC recommendation may be better suited to focused screening efforts in the Sunshine State. GIS was central to this conclusion, and it is the hope of this researcher that GIS continues to play a significant role in the effort to eliminate childhood lead poisoning in Florida and around the world.

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